

## CLAIMS

What is claimed is:

- 5 1. A method for determining an exponential decay rate of a signal in the presence of noise, said method comprising:
- receiving an exponentially decaying signal from a detector;
- 10 digitizing said signal to form a first array of data points;
- estimating a baseline value of said signal by averaging a final fraction of said data points;
- subtracting said baseline value from said first array to generate a second array;
- 15 identifying a last data point on said second array occurring before a negative or nil valued data point on said second array;
- scaling an ordinate value of said last data point by a factor greater than unity to determine a new first data
- 20 point for a baseline fit on said first array;
- fitting remaining data on said first array to a straight line to determine an estimate for a sloping baseline and said noise;
- subtracting said straight line from said data points to
- 25 establish a resulting array;
- identifying a last data point on said resulting array occurring before a negative or nil valued data point on said resulting array;
- performing a logarithmic transformation of said
- 30 resulting array up to said last data point on said resulting array; and
- determining said decay rate of said signal.

2. The method of claim 1 wherein said determining step includes determining said decay rate of said signal by a weighted least squares fit to said transformed data.

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3. The method of claim 2 wherein said weighted least squares fit includes weighting each transformed data point inversely proportional to a square of said value of said digitized signal minus said estimated baseline value.

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4. The method of claim 1 wherein said signal is generated in a ring-down cell.

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5. The method of claim 4 wherein said ring-down cell includes two or more mirrors in any geometry that produces a stable optical cavity.

6. The method of claim 1 wherein said detector includes a photodetector.

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7. The method of claim 1 further comprising removing transient points from said first array.

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8. The method of claim 1 wherein said subtracting a baseline value includes subtracting a DC level.

9. The method of claim 7 wherein said subtracting a baseline value includes subtracting a DC level.

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10. The method of claim 1 wherein said noise includes broadband noise and excess low frequency noise.

11. The method of claim 10 wherein said low frequency noise has spectral components having a period greater than four times a record length.

5 12. The method of claim 4 further comprising energizing said ring-down cell.

13. The method of claim 12 wherein said energizing step includes utilizing a laser.

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14. The method of claim 13 wherein said laser is a continuous wave laser.

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15. The method of claim 13 wherein said laser is a pulsed laser.

16. A ring-down cavity system for determining an exponential decay rate of a signal in the presence of noise comprising:

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a ring-down cavity;

a light source for injecting light into said cavity;

a detector;

a digitizer; and

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a processor for determining said decay rate by fitting a straight line to a curve associated with said decay rate at a time greater than where a negative or nil value is detected, removing undesirable data associated with said noise and logarithmically transforming said data.

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17. The system of claim 16 wherein said light source is a laser.

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18. The system of claim 17 wherein said laser is a pulsed laser.

19. The system of claim 17 wherein said laser is a  
5 continuous wave laser.

20. The system of claim 16 wherein said dectector is a photodectector.

10 21. The system of claim 16 wherein said processor for determining said decay rate further includes removing an estimated value of said noise from said signal.

22. A method for processing a data record to determine an  
15 associated decay rate of a species in the presence of noise, said method comprises:

subtracting a DC offset from said data record;

determining a time associated with a first data point  
occurring before a first negative or nil data point of said  
20 data record;

scaling said time by a factor greater than unity to  
determine an end time associated with a portion of said data  
record, said end time having a corresponding value;

25 averaging data points from said time value to the end  
of record;

subtracting said value from each data point from said  
data record to create a new data record;

determining an end point for said new data record  
associated with a first data point before a first negative  
30 or nil data point of said new data record;

logarithmically transforming said new data record; and

determining a decay rate from said logarithmic transform.

23. A method of measuring the decay rate of a signal having  
5 noise, said method comprising:

measuring a data signal having noise;

forming a data array having data values associated with  
said signal;

subtracting undesirable data values from said array;

10 establishing a resulting array;

testing said resulting array for a first negative or  
nil value;

forming a new array ending at one value before said  
first negative or nil value;

15 performing a logarithmic transformation on said new  
array; and

determining said decay rate from said logarithmic  
transformation.

20 24. A method for determining an exponential decay rate of a  
signal in the presence of noise, said method comprising:

receiving an exponentially decaying signal;

digitizing said signal;

removing an estimated noise value from said signal;

25 identifying a cutoff point associated with said signal;

scaling said cutoff point by a factor greater than  
unity;

determining a new estimated noise value;

30 removing said new estimated noise value from said  
signal;

identifying a last point of said signal before a negative or nil valued data point on said resulting array; and

performing a logarithmic transformation to determine  
5 said decay rate of said signal.

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